APOLLO
G & N SPECIFICATION
ND 1002031
TIRR NO 0 6 4 2 7
7 January 1964
CLASS A Release

DESCRIPTION AND REQUIREMENTS

FOR

PROCESS FOR

SOLDERLESS WRAPPED CONNECTIONS PROCESS

Record of Revisions

Revision Letter	TIRR Number	Pages Revised	Approvals		Date
			MIT	NASA	

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DESCRIPTION AND REQUIREMENTS FOR SOLDERLESS WRAPPED CONNECTION PROCESS

1. The purpose of this document is to outline standards and controls for making solderless wrapped connections. This document is intended for use in the APOLLO Guidance and Navigation Equipment program.

W Kupfer 18 Feb 64
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NASA/MSC APPROVAL

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7 January 1964

DESCRIPTION AND REQUIREMENTS

FOR

SOLDERLESS WRAPPED CONNECTIONS PROCESS

1. SCOPE

1.1 Scope. This specification covers process standards and controls for making solderless wrapped connections. Such connections will provide electrical and mechanical joints capable of meeting the performance requirements and environmental conditions of APOLLO guidance and navigation electronic equipment. Qualification requirements of the tools used in the process are also covered.

1.2 Terminology. The parts which form a solderless wrapped connection along with terminology used in this specification are illustrated in Figure 1.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS:

Federal -

Fed. Test Method Std. No. 151	Metals, Test Methods

Military -

MIL-G-45204	Gold Plating (Electro-deposited)
MIL-W-16878	Wire, Electrical, Insulated, High Temperature

STANDARDS:

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-105	Sample Procedures and Tables for Inspection by Attributes

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DESCRIPTION AND REQUIREMENTS

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PROCESS FOR

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A	15801	IV, 1, 4, 5, Add 18-IX, 33-38	WAK	[illegible]	30 Dec. 1964

This specification consists of pages i through iv and pages 1 through 38 inclusive.

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7 January 1964

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DESCRIPTION AND REQUIREMENTS FOR SOLDERLESS WRAPPED CONNE CTIONS PROCESS

1. SCOPE

1.1 Scope. This specification covers process standards and controls for making solderless wrapped connections. Specific requirements or provision not covered by this specification shall be as specified on the applicable drawing. In the event of conflict between the requirements of the applicable drawing, this specification and other documents cited herein, the requirements of the applicable drawing, this specification and the other documents specified herein shall govern in that order.

The provision of this specification shall be applicable to all phases of wrapping of electrical connections to the extent specified herein.

Paragraph 3.2 through 3 are applicable to automatic wire wrapping machinery and shall govern when such equipment is used by the contractor. Paragraph 70 through 00.1 are applicable to powered hand wrapping tools and shall govern when such tools are used by the contractor.

1.2 Terminology. The parts which form a solderless wrapped connection along with terminology used in this specification are illustrated in Figure 1.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS:

Federal -

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STANDARDS:

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-105	Sample Procedures and Tables for Inspection by Attributes

DRAWINGS:

1006945	Wire, Electrical, Insulated
1006732	Wire, Electrical, Insulated

3. REQUIREMENTS

3.1 Description. Solderless wrapped connections shall be made by wrapping a specified number of turns of wire, under tension, around a rectangular post having four sharp edges. The sharp edges of the wrapost produce high pressure points resulting in indentations on either the wire or both to meet the requirements of stripping forces per paragraph 3.4.1.2. The resulting gas tight high pressure points provide electrical continuity and mechanical stability. Wrapost connections covered by this specification shall be in accordance with the following:

The wrapped connection shall include a minimum of 1/2 turn of insulated wire followed by the specified number of turns of bare wire (See Table III).

3.2 General Requirements

3.2.1 Preproduction Samples. Unless otherwise specified in the contract or order, preproduction samples of the solderless wrapped connections shall be manufactured using the methods and procedures intended for the production lot. Samples of solderless wrapped connections shall be tested as specified in Section 4 herein for the purpose of determining that the production item meets the requirements of this specification, and that the process is properly controlled.

3.2.2 Solderless Wrapping Tools and Bits.

3.2.2.1 Wrapping. All wrapped connections shall be made with automatic wrapping tools and bits adjusted and tested in accordance with the requirements of 3.3.

3.2.3 Wrapost Design Requirements

3.2.3.1 Wrapost Cross Section. The wrapost cross-section shall be square and nominally measure 0.040 x 0.045 inches in the square plane for 24 (AWG) wire and .025 x .025 inches in the square plane for 30 (AWG) wire.

3.2.3.2 Edge Radius. All wraposts shall have sharp edges to insure good contact with the wire when wrapped. The corner radii of the edges shall not exceed 0.003 inches after plating. Edge burrs shall not exceed 0.0015 inches.

3.2.3.3 Length. The minimum effective length of the wrapost measured from the wrapost retainer to the base of the wrapost apex, shall be as shown in Table I for the applicable number of wrappers and wire size.

3.2.3.4 Durability. Wrapost shall be durable enough to withstand being unwrapped and rewrapped a minimum of 10 times and still comply with the requirements of 3.4.1.2.

3.2.3.5 Material. Wraposts shall be made from a suitable copper alloy having hardness of from Rockwell C25 to 40.

Table I. Wrapost Length

Wire Size (AWG)	Nominal Wire Dia (Inches)	Wire Circular Mils	Effective Length Min Values in Inches		
			1 Wrapper	2 Wrappers	3 Wrappers
24	.0201	404	0.210	0.420	0.660
22	.0200	101	0.175	0.350	0.525

3.2.4 Gages. The contractor shall provide himself with whatever gages are necessary and adequate to insure that the material to which this specification applies will meet the dimensional requirements shown on the applicable drawings. If as stipulated in the contract, order or requisition, the Government will furnish drawings of pertinent inspection gages for guidance in the design of the contractor's inspection gages. However, such procedure shall not serve to relieve the contractor of his responsibility in the design and manufacture of such gages as may be required for the satisfactory fulfillment of the contract requirements, but is intended to facilitate acceptance of all components and assemblies by NASA Inspection Gages.

3.2.5 Preparation of Wire

3.2.5.1 Insulation Stripping. The following precautions shall be taken when stripping insulation:

(a) The insulation shall be removed without injuring the conductor in any way.

(b) Length of insulation stripped shall be as specified in Table III.

3.2.6 Solderless Wrapped Process. Solderless wrapped connections shall be made with automatic wrapping tools capable of wrapping connections which conform with all requirements of this specification. The sequence of operations for making wrapped connection shall be as follows. See Figure 2 for operations required which are as follows:

(a) Verify that the tool meets the requirements as specified in 3.3.

(b) Place tool (large hole) over the wrapost.

(c) Rotate the tool spindle (1) around the wrapost.

(d) Remove tool from wrapost.

3.2.6.1 Wrapost Spacing. Wrapost spacing shall allow sufficient room to accommodate the wrapping tool when spaced on multiples of .025 grid coordinates. For machine wrapping, spacing shown in Table II is preferred.

Table II. Wrapost Spacing

(AWG) Wire Gage	(Tool Space) Effective Bodies	.045 x .045 Wrapost Spacing Min.	.025 x .025 Wrapost Spacing Min.
24	.124	.20	--
30	.124	--	.125

3.2.6.2 Wrapper Turns. Total wrapper turns shall be as specified in Table III. The maximum space between turns shall be one half the bare wire diameter (first and last turns excepted). There shall be no overlap of turns to the last locked point (last wrapost corner) within the minimum turns specified. When using a hand tool, there shall be no axial force exerted on the wrap during the wrapping process in excess of the static weight of the wrapping tool. A turn shall be complete when it has made contact with the four corners of the wrapost. (See figures 9 through 13 and figure 6).

3.2.7 Positioning of Wire

3.2.7.1 Prior to wrapping, the wire shall be positioned radially so that subsequent routing of the unwrapped portion of the wire does not tend to unwrap the connection.

Table III. Number of Wrapper Turns

Wire Gage (AWG)	Number of Turns	Length of Insulation Stripped
24	5 min. to 6 max.	1 5/16 Nominal
30	7 min. to 9 max.	1 1/16 Nominal

Each wrap shall consist of the specified number of turns of bare wire plus 1/2 to 2 turns of insulated wire.

3.2.7.2 First Wrapper. The first wrapper (Z_1) on all wrapost shall be placed in accordance with Figure 6.

3.2.7.3 Additional Wrappers. When more than one wrapper is connected to a wrapost, all subsequent wrappers (Z_2 and Z_3) shall be positioned in accordance with Figure 6.

3.2.7.4 Wrapper End. The final turn of any wrapper shall not extend away from the outside diameter of the stripped wire on the wrapost by more than the diameter of the stripped wire. (See figure 15)

3.2.7.4.1 Wire Dressing. No metallic tools, probes or sharp instruments shall be used in dressing wires except blunt tools approved by the government inspector. Wrapped connections must not be subject to an axial pulling force on the wire which would tend to unwrap the connections. The wires should be dressed at right angles to the wrapost axis.

3.2.8 Materials. Unless otherwise specified in the contract or order, all materials and purchased parts entering into the assembly of the solderless wrapped connections shall conform strictly to the details indicated in applicable specifications and drawings.

3.2.8.1 Wire

3.2.8.1.1 Insulated Wire. For size #24 (AGW), insulated wire shall be solid, tin coated, copper conductor of proper hardness to indent, or be indented by the wrapost when wrapped. Insulation shall be of Polyvinyl Chloride with a Polyamide (nylon) jacket per ND 1002107. For size #30 (AWG) insulated wire shall be a high strength copper alloy, solver plated, with insulation per 1006732.

3.2.8.1.2 Bare Wire. For size #24 (AWG), bare wire shall be tin coated, copper conductor meeting the requirements of ND 1002107 relative to conductor only. For size #30 (AWG), bare wire shall be silver plated, high strength copper alloy conductor meeting the requirements of 1006732 relative to conductor only.

[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] complete

(1) Vibration tester

(4) Vibration

[illegible]. REQUIREMENTS

3.2 PROCESS CONTROL

APOLLO
G&N Specification

30 December 1964


WRAPOST INSERTED
TYPICAL CONNECTION

1. The stripping jaw shall engage at right angles to axis of the wrapost.
2. The maximum total clearance between jaw opening and wrapost shall be 0.7 diameter of wire.
3. When the wrapost and stripping fixture are properly aligned, the clearance shall be such that there is no binding or wedging between jaw and wrapper.
4. Both sides of the stripping jaw shall be in the same plane, creating a flat surface contact with the wire on either side of the wrapost.

APOLLO
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WRAPPER LOCATION

1/16. max.

Translation icicle too long;

APOLLO

STRIPPING DIMENSIONS

CONNECTION TURNS

OPEN WRAP TURNS

SPIRAL AND OVER WRAP

INSUFFICIENT INSULATION WRAP

Figure 1.

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DEBITUPLE CONNECTIONS

Apollo Guidance

REQUIREMENTS

NOTES

Table I. Wrapper Length

1/2 of 15 of full scale

(4) Vibration tester

.7 Acceptance Testing

J.L.S. (S) Confidential

[illegible] REQUIREMENTS

[illegible]

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DESCRIPTION AND REQUIREMENTS

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A	15004	IV, 1, 4, 5, Add 18-25, 31-34	WHC	[illegible]	30 Dec. 1964
B	17527	11, 23, 31, 32, 33, 34, 35, 36, 37, 38	WHC	[illegible]	1 April 1965
(M) C	29316	All Pages	[illegible] F.G.	[illegible] F.G.	2 June 1966

This specification consists of pages 1 through 25 inclusive.

FIG. 4 BARE WIRE STRIPPING

4.7.2 Test Procedure

4.7.2.1 Visual Inspection. A comprehensive inspection shall be made of connections (Per Paragraph 4.3.1.2) submitted for acceptance to determine the extent of compliance with the requirements of this specification and other documents referenced. Requirements to be verified are listed in Table IV. Visual inspection shall be performed on wirewraps to determine if the wire has been damaged or broken.

Failure of a connection to meet all or any requirements listed in Table IV shall be cause for rejection. Any wrapost which is replaced or repaired shall be inspected. Inspection shall be performed at a magnification of at least 3 power for 26 (AWG) wire or larger and at least 7 power for sizes smaller than AWG 26 Wire.

4.7.2.2 Wrap Connection Resistance. Voltage drop shall be measured using the sample connections prepared in accordance with 4.2.1.3. With the current stabilized, the voltage drop shall be in accordance with the requirements of 3.4.2.1 (see Figure 16). The lot represented by the sample shall be rejected if the sample fails to meet the requirements.

4.7.2.3 Wrap Connection Stripping. Samples made as specified in 4.2.1.3 shall be tested using a test fixture illustrated in Figure 15. The clearance between the wrapost and the test fixture jaws shall not exceed 70 percent of the wire diameter. The stripping force shall be applied at a uniform rate of 1 inch to 10 inches per minute, and shall comply with the requirements of 3.4.1.2. The minimum displacement of the wrapper along the wrapost shall be a distance equal to one diameter of the wire. The maximum displacement of the wrapper along the wrapost shall be limited to avoid an increase from the initial break-away (starting) strip force. The lot represented by the sample shall be rejected if the sample fails to meet the requirements. Wrap shall not be pulled over top of pin.

4.7.2.4 Unwrapping(for Qualifying Tools, Wire). Samples shall be tested by unwrapping with a tool designed for the particular size being unwrapped. The unwrapping tool shall be placed over the wrapost and its leading edge engaged between the wrapper end and the next wrapper turn. The unwrapping tool shall then be rotated until all of the wire has been transferred onto the tool. The unwrapping tool, with the loose helical coil of wire shall then be removed from the wrapost. The insulated portion of the wire is held firmly while the unwrapping tool is rotated so as to unwind the wire from the tool. It is not necessary that the unwrapped wire be perfectly straight. Waves or permanent deformation are permissible. The wire shall not break during the unwinding process.

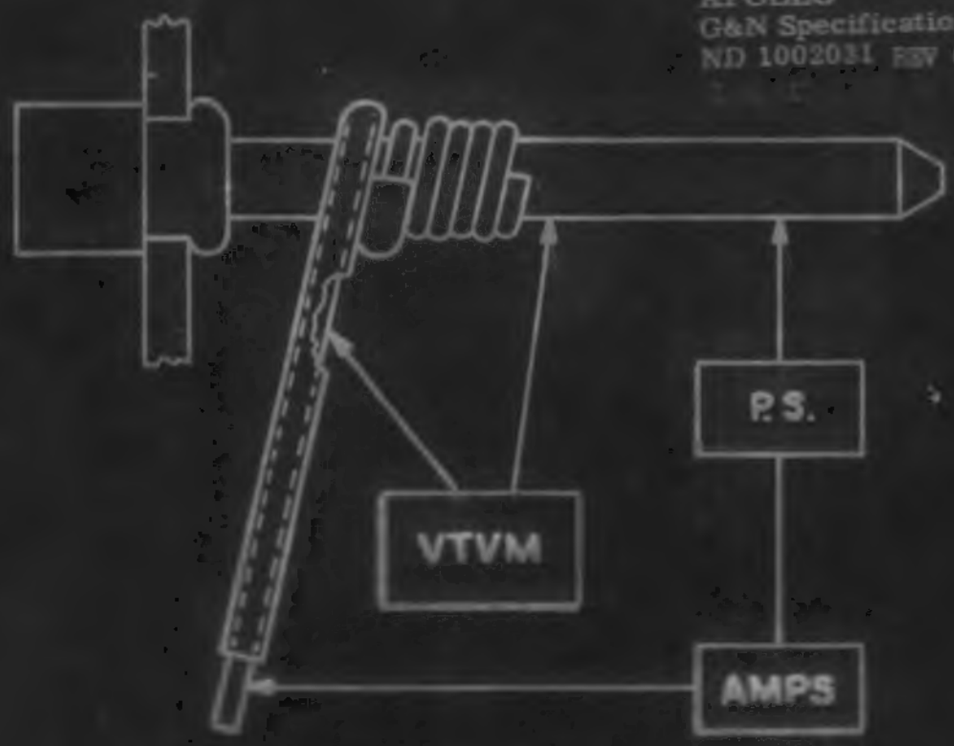

Figure 16. WRAP CONNECTION RESISTANCE DIAGRAM

This test is only a test of wrap resistance. The test probes making contact to wire should be as close to the wire wrap as practicable without disturbing the wrap. This will avoid the false indication resulting from measuring the voltage drop due to wire resistance.